Memorandum

Re: **Final Emerging Issues Paper**
UAS in Washington State

Introduction

UAS Integration Review

The rise of Unmanned Aircraft Systems (UAS) integration into the National Airspace System (NAS) has become one of the most impactful events on the history of aviation. Just as the Grand Canyon crash in June 1956 led to the creation of the Federal Aviation Administration (FAA) for regulation and safety of air traffic operations nationwide, the emergence of UAS for routine commercial and civilian operations is forcing many stakeholders to reevaluate the entire aviation transportation system. Both traditional-aviation and non-aviation industry contributors are now developing technologies, services, and product packages that offer new capabilities related to UAS operations in the NAS. Legislatures, regulatory authorities, and standards organizations globally are evaluating strategies or implementing new structures and laws for managing the integration of UAS to protect the safety and integrity of civilian airspace, while also protecting the privacy rights of citizens. Education and certification requirements to meet evolving standards and regulations are as dynamic as the emerging UAS-based applications markets. There are many initiatives globally and nationally that are influencing the proliferation of UAS including standards development, research programs, advocacy efforts, and information programs.

Industry

The UAS industry as a whole encompasses a wide range of demographics. Traditional aerospace contractors such as Boeing, Lockheed Martin, and Northrup Grumman are actively engaged in the UAS industry. They are developing technologies, acquiring smaller companies with UAS products, or integrating other solutions into their capability portfolios. Other large companies like Intel and Google that specialize in computing and information management, not aviation products, are also emerging as major players

Figure 1: UAS Industry Representatives

in the UAS community. Small businesses have created the most disruption in the UAS sector in recent years with the explosion of the consumer-grade UAS companies like DJI and 3D Robotics.

The UAS industry (Figure 2) should not be strictly defined by the companies that are manufacturing the aircraft. Hardware components such as sensors, avionics, transponders, ground control stations, and batteries are evolving at least as fast as small airframe designs. Increased battery performance to extend endurance or power more sensors translates directly to increased system capability. Software development for advanced autonomy, vehicle operating systems, information management, image processing, and data analysis is another big area of growth. Companies like Airware, Sierra Nevada

Corporation, and DJI are investing large amounts of money into developing or acquiring software to gain a competitive advantage in the UAS market.

The UAS Industry

Flight Management Software

Airframes

Engines

Batteries

Training

Services

Ground Control Stations

Avionics

Ground Radios / Antennas

Ground equipment

Onboard Radios / Antennas

Data Processing Software

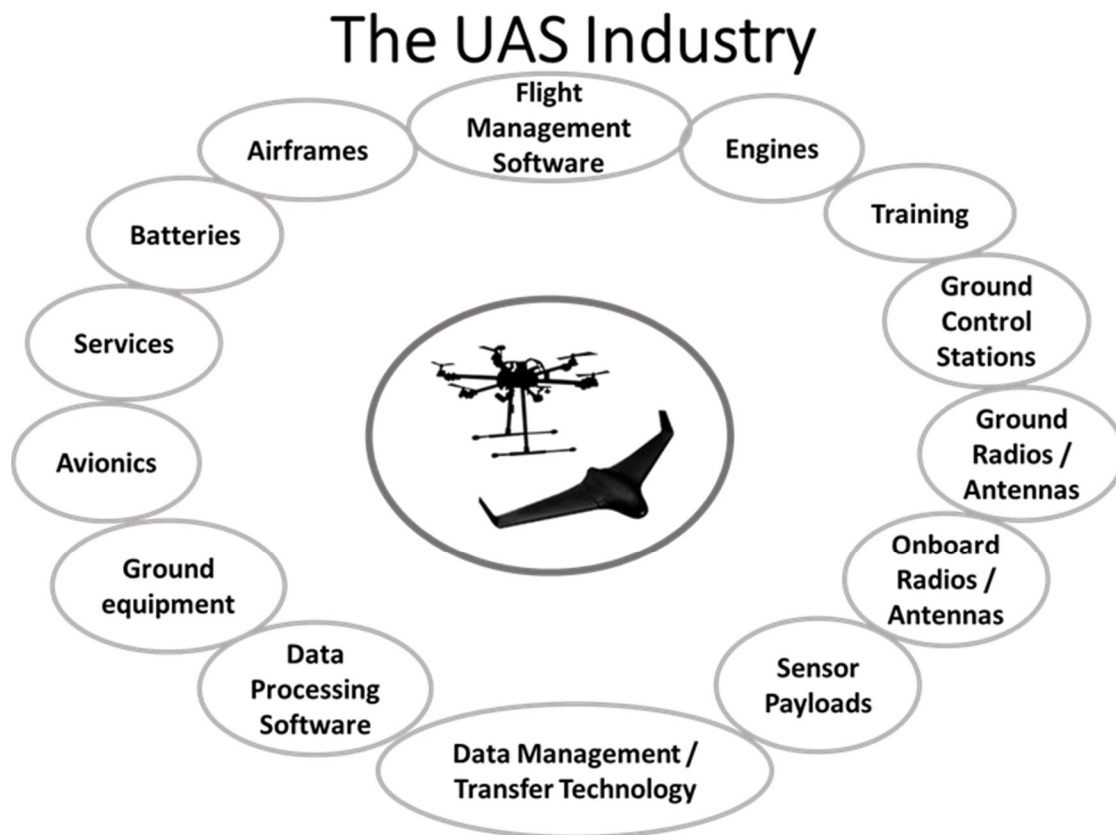Sensor Payloads

Data Management / Transfer Technology

Figure 2: Types of UAS Industry Providers

Not all of the companies in the UAS industry are developing technologies or manufacturing products. Hundreds of companies that did not exist at the beginning of 2015 began offering UAS services in the United States. While many of these were legally offering UAS aerial photography and surveying services under the FAA's Section 333 Exemption program, many other service providers were acting outside the current regulatory structure for a variety of reasons (informed defiance, unaware, etc.). Measure 32, Juniper Unmanned, Boeing's Insitu, and SkyPan International are some of the more recognized names offering UAS services. Many organizations have chosen to build UAS operations units inside existing corporate structures such as engineering firms, construction companies, and film making studios. In June of 2016 when the FAA temporarily suspended the 333 Exemption process to release the Part 107 Small UAS Rule, the FAA had approved more than 5,500 exemptions for commercial operations. At that same time the FAA UAS registration program surpassed 500,000 registrations (General Aviation registration is widely estimated around 250,000 aircraft). These aircraft and exemptions were approved for a wide range of applications and missions (Figure 3).
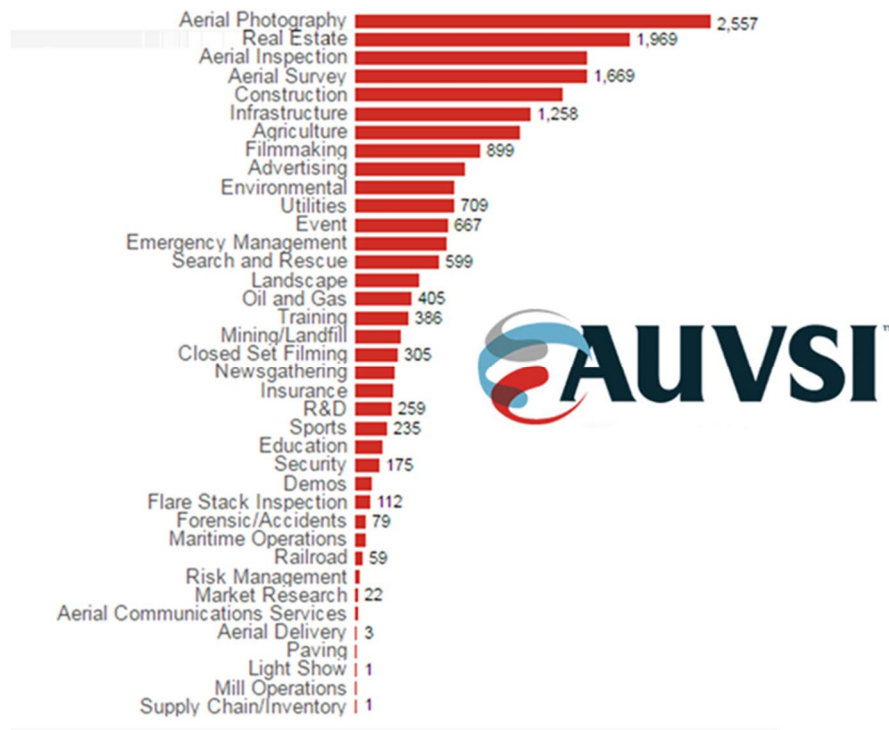
Figure 3: AUVSI Analysis of First 3,100 333 Exemptions
(AUVSI, AUVSI Commercial Exemptions Interactive Analysis, 2016)

Legislation

Just as the profile for a UAS industry organization takes many shapes, the approaches to UAS legislation across the country also span a wide range of expectations. The FAA responsibility to protect the safety of the national air transportation system provides the agency with the prime authority nationwide. In December of 2015 the FAA reminded the public and other government authorities of this responsibility vested in the Agency from Congress by releasing a Fact Sheet for State and Local Regulation of UAS (FAA, 2015). That Fact Sheet states the FAA's authority in multiple examples:

"A consistent regulatory system for aircraft and use of airspace has the broader effect of ensuring the highest level of safety for all aviation operations. To ensure the maintenance of a safe and sound air transportation system and of navigable airspace free from inconsistent restrictions, FAA has regulatory authority over matters pertaining to aviation safety."

"Substantial air safety issues are raised when state or local governments attempt to regulate the operation or flight of aircraft. If one or two municipalities enacted ordinances regulating UAS in the navigable airspace and a significant number of municipalities followed suit, fractionalized control of the navigable airspace could result. In turn, this 'patchwork quilt' of differing restrictions could severely limit the flexibility of FAA in controlling the airspace and flight patterns, and ensuring safety and an efficient air traffic flow."

The FAA originally used three methods for approving UAS operations in domestic airspace: (1) the Certificate of Authorization (COA) program for public agencies; (2) the Section 333 Exemption process for commercial UAS operations; and (3) the Special Airworthiness Certificate for UAS operations. Each of these methods is well-defined and discussed in various online resources including the FAA's website (http://www.faa.gov/uas/) and articles from industry experts. In February of 2015 the FAA released the long-awaited Notice of Proposed Rule Making (NPRM) for small UAS operations. After the 60-day public comment period closed, the FAA had approximately 4,500 comments to process and integrate into the final rule. On June 22, 2016 the FAA released 14 CFR Part 107, Operation and Certification of Small Unmanned Aircraft Systems. This rule is known as "Part 107, the Small UAS Rule." On August 29, 2016 Part 107 became effective and the FAA began issuing Remote Pilot in Command certificates. A summary of major provisions is outlined in Appendix B. Part 107 is expected to provide the structure for most small UAS operations, although the FAA is maintaining the public COA process for public agencies and a waiver/exemption process for operations outside of the Part 107 requirements. Table 1 provides a brief comparison summary of the FAA approval methods for UAS operations.

Table 1: FAA UAS Operations Authorization Methods

	Public COA	333 Exemption	Special Airworthiness Certificate	Part 107
Operator Certification	Agency determined (private ground school or Pilot's License)	Minimum FAA Sport Pilot's License	Minimum FAA Sport Pilot's License	FAA Remote Pilot Certificate
Altitude Limit	COA- specific	200' blanket approval Up to 400' with COA	Location specific, determined by FAA	400' AGL or within 400' of a structure
Aircraft Size Limit	COA-specific	55 lbs	Aircraft specific	55 lbs
Operational Time	COA-specific (some night ops are allowed)	Daylight hours only	Operation specific, determined by FAA	Daylight hours only
Visual Requirement	Line-of-sight only	Line-of-sight only	Operation specific, determined by FAA	Line-of-sight only
Visual Observer	Required	Optional	Operation specific, determined by FAA	Optional
Airworthiness Requirement	Self-certified	Exempt	Full FAA certification	Pre-flight inspection

![WASP - Washington Aviation System Plan logo]

As of December 2015, many states (see Figure 4) are also evaluating proposed legislation or implementing approved legislation to immediately help manage the growing demand of UAS across the country. More than a dozen states have established a UAS Task Force or some kind of committee specifically to assess the need for UAS legislation in their respective state. More than half of the country has passed legislation that addresses UAS operations, data capture, equipage, or illegal activity.

2015 State UAS Legislation Interactive Map

Highlight each state for legislative details. Click on the state for more info.
Red = Active Bills; **Green** = Bills Defeated; **Blue** = Bills Passed.
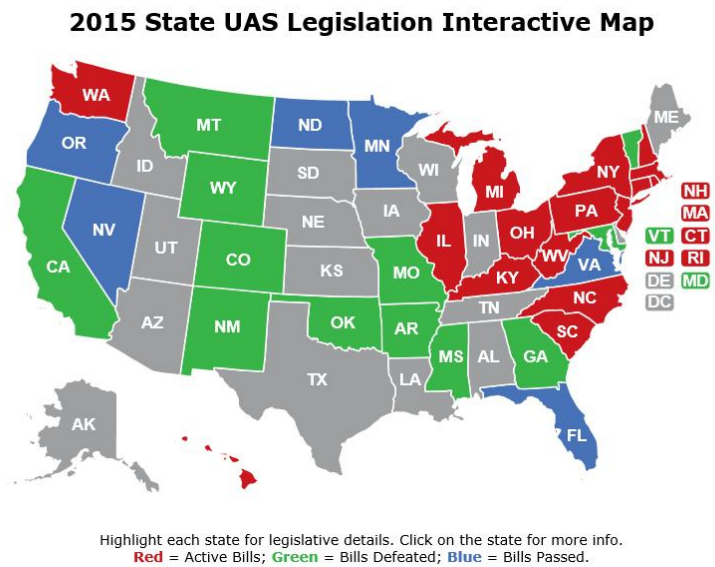
Figure 4: UAS Legislation Map

More details on this will be discussed later in the report. Just as when the FAA was established as a national regulator, the definitions of "airspace," "preemption authority over airspace," "control authority," and regulatory enforcement responsibilities are being reviewed at all levels.

Education/Training/Certification

As the FAA continues progressing toward broad integration for small UAS commercial operations, government agencies, universities, and private companies are using a variety of platforms to fill the UAS information needs. The FAA has multiple information websites covering UAS topics including details on Part 107, the Section 333 Exemption program, Model Aircraft Do's and Don'ts (FAA, FAA UAS Website, n.d.), and a UAS Roadmap (FAA, FAA UAS Website, n.d.) for long term planning. State departments of transportation and aeronautics authorities are posting UAS information pages with fact sheets and local knowledge (for example, the North Carolina and Minnesota UAS websites). Universities are offering UAS curricula for degrees and certificates in UAS operations. Aerospace engineering programs are still building small UAS as senior design or capstone projects, while higher level computer science classes are using UAS as platforms for demonstrating advanced artificial intelligence, dynamic networking, and human-machine collaboration knowledge comprehension. Remote sensing and Geospatial Information Systems (GIS) programs are integrating UAS data capture methods and samples into classes on modern surveying and image analysis skills techniques. Finally private companies are specializing in UAS operating training programs at the same time that traditional flight schools are also developing UAS-specific flight training programs building on existing Part 61 and Part 141 approvals. The challenge all of these organizations face is the FAA evolving definition of the requirements for the UAS operator license, including the transition from 333 exemptions that required a minimum Sport Pilot license to the creation of the new Remote Pilot certificate. As of August 2016 there is no such thing as an "FAA-approved UAS Flight School" or an "FAA-recognized degree program" to certify UAS professionals. Providing up to do date, accurate information that includes any pertinent and related local relevance is

critical for state and local governments to keep their citizens informed. But as the regulatory and standards landscapes continue to evolve, the certification, permitting, registration, and education requirements for a professional UAS career will also continue evolve.

Applications

The demand for UAS in the national airspace is driven by the value that UAS capabilities are now providing users for a wide variety of applications. Although the benefits of UAS for aerial imagery were primarily isolated to the national defense community, the commercial sector and civilian services providers have begun adopting the technology and reaping the benefits. Although not an exhaustive list of applications, Figure 5 presents a core set of missions that many state governmental agencies and commercial services companies are performing under current FAA authorizations:

Sample UAS Applications	
Mapping / Surveying	Investigation
Aerial Photography	Drug Enforcement
Agriculture	Anti-terrorism
Mining	Law Enforcement
Forestry	First Responder Support
Wildlife Resources	Disaster Analysis
Transportation	Emergency Response
Weather Research	Insurance Assessments
Airport Planning	Real Estate Photography
Entertainment / Filming	Construction Management

Figure 5: Example UAS Applications

Major Initiatives

The continued acceleration and momentum of UAS growth provides several key initiatives worth tracking. The following examples of UAS leadership provide a description of the initiative and the value to the UAS integration community.

- The FAA UAS Center of Excellence: This is a 5-year funded research program for a university-led team of research institutions, industry partners, and government agencies to tackle the challenges facing UAS integration today and in the future. Mississippi State University leads a 22-school alliance called ASSURE (www.assureuas.org) that was selected by the FAA for the UAS COE in May of 2015. *Value*: Research specifically designed to accelerate the broad, safe integration of UAS into the National Airspace System. Academia, industry, and government agencies are collaborating to research current and future needs for UAS operations in domestic airspace.

- The FAA's UAS Test Sites (FAA, FAA UAS Website, n.d.): In December of 2013, six UAS test sites were selected to achieve cross-country geographic and climatic diversity and help the FAA meet its UAS research needs. The six sites are managed by the University of Alaska, State of Nevada, New York's Griffiss International Airport, North Dakota Department of Commerce, Texas A&M University-Corpus Christi, and Virginia Tech through the Mid-Atlantic Aviation Partnership. In June of 2016 the New Mexico State University's UAS Flight Test Center, which was the model for the other six test sites, was officially recognized as an FAA UAS Test Site when the FAA Extension, Safety, and Security
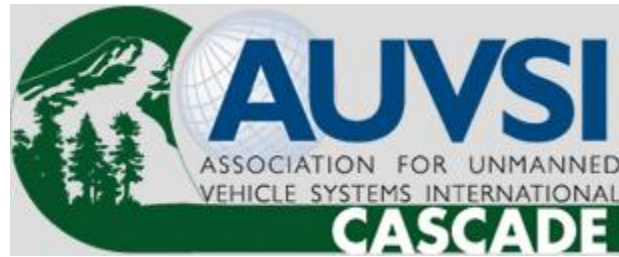
Act of 2016 was signed into law (Staff, 2016). *Value*: Working with the UAS Test Sites is the FAA-preferred method for researching and evaluating new technologies related to UAS integration. The Pan-Pacific UAS Test Range Complex is the official FAA test site managed by the University of Alaska, but includes facilities in Oregon, Hawaii, Kansas, and several other states. Washington State could consider collaborating with a UAS Test Site to evaluate UAS regulations and policies.

- Know Before You Fly and the B4U Fly App (FAA, FAA UAS Website, n.d.): The "Know Before You Fly" campaign started in December of 2014, when the AUVSI, the Academy of Model Aeronautics (AMA), the Small UAV Coalition, and the FAA partnered to provide prospective UAS operators with the information and guidance needed to fly safely and responsibly. The campaign plans to team with manufacturers and distributors to provide consumers and businesses with the types of information needed before flying a UAS. The information is provided through a website, educational videos, point-of-sale materials, and digital and social media campaigns. The "Know Before You Fly" website (http://knowbeforeyoufly.org/) contains pages with information applicable to recreational users, public entities, and business users. It contains contact information, links to additional resources, and printable brochures aimed at enhancing UAS operations. Airport operators can steer stakeholders and members of their communities toward the campaign materials as a starting point for local UAS discussions. (Neubauer, 2015, p. 27).

    B4UFLY is a smartphone app that helps unmanned aircraft operators determine whether there are any restrictions or requirements in effect at the location where they want to fly. *Value*: These two initiatives are providing the general public free tools and information to safely operate UAS from a consumer and novice perspective.

- RTCA SC-228 Minimum Operational Performance Standards for Unmanned Aircraft Systems Committee: "Established May 20, 2013, this committee is working to develop the Minimum Operational Performance Standards (MOPS) for "Detect and Avoid" (DAA) equipment and a Command and Control (C2) Data Link MOPS establishing L-Band and C-Band solutions. The initial phase of standards development will focus on civil UAS equipped to operate into Class A airspace under IFR flight rules. The Operational Environment for the MOPS is the transitioning of a UAS to and from Class A or special use airspace, traversing Class D and E, and perhaps Class G airspace. A second phase of MOPS development is envisaged to specify DAA equipment to support extended UAS operations in Class D, E, and perhaps G, airspace." (RTCA, n.d.) *Value*: Standards committees are always looking for more participants with technical and policy knowledge. These are the most impactful activities shaping the long term standards, procedures, and definition related to UAS integration.

- The Small UAV Coalition: "The Small UAV Coalition advocates for law and policy changes to permit the operation of small unmanned aerial vehicles beyond the line-of-sight, with varying degrees of autonomy, for commercial, consumer, recreational and philanthropic purposes." (Small UAV Coalition, n.d.) *Value*: With members like Amazon and Google, the Small UAV Coalition is the dedicated voice for the emerging commercial UAS services industry. Companies based in Washington are joining the coalition, so state policies and opportunities will be used for examples.

- The Association for Unmanned Vehicle Systems International (AUVSI): "The Association for Unmanned Vehicle Systems International is the world's largest non-profit organization devoted exclusively to advancing the unmanned systems and robotics community. Serving more than 7,500 members from government organizations, industry and academia, AUVSI is committed to fostering, developing, and promoting unmanned systems and robotic technologies. AUVSI members support defense, civil and commercial sectors." (AUVSI, n.d.) *Value*: AUVSI has the reputation in Washington, D.C. and globally for shaping the entire unmanned systems industry and policy. The Cascades Chapter of AUVSI was established to support the community in the northwest region of the United States.

- FAA UAS Registration Task Force (FAA, 2015): In October of 2015 a Registration Task Force was established to provide the FAA Aviation Rule Making Committee direct recommendations regarding UAS registration strategies and needs. The FAA charged the Task Force with the following three objectives:

  − Develop and recommend minimum requirements for UAS that would need to be registered.
  − Develop and recommend registration processes.
  − Develop and recommend methods for proving registration and marking

  On November 21, 2015 the RTF submitted their report to the FAA for immediate consideration. On December 21, 2015 the FAA released Registration and Marking Requirements for Small Unmanned Aircraft Interim Final Rule (FAA, 2015). This rule provides an alternative, streamlined and simple, web-based aircraft registration process for the registration of small unmanned aircraft, including small unmanned aircraft operated as model aircraft, to facilitate compliance with the statutory requirement that all aircraft register prior to operation. It also provides a simpler method for marking small unmanned aircraft that is more appropriate for these aircraft. *Value*: This registration requirement is law and was a major step forward toward Part 107.

- UAS Traffic Management (UTM) Program, NASA Ames Research Center: A UTM system would enable safe and efficient low-altitude airspace operations by providing services such as airspace design, corridors, dynamic geofencing, severe weather and wind avoidance, congestion management, terrain avoidance, route planning and re-routing, separation management, sequencing and spacing, and contingency management. UTM is essential to enable the accelerated development and use of civilian UAS applications.

  One of the attributes of the UTM system is it will not require human operators to monitor every vehicle continuously. The system will provide to human managers the data to make strategic decisions related to initiation, continuation, and termination of flight operations. This approach would ensure that only authenticated UAS operate in the airspace. In its most mature form, the UTM system will be developed using autonomicity (also known as autonomous, or self-directing)

characteristics which will include self-configuration, self-optimization and self-protection. The self-configuration aspect will determine whether the operations should continue given the current and/or predicted wind/weather conditions. (NASA, n.d.) Value: The collaboration of FAA, NASA, and industry under the UTM concept is defining national, state, and local level technology, policy, and application expectations (Figure 6). UTM progress needs to be monitored.

Figure 6: NASA UAS Traffic Management Concept

Framing the Impact of UAS on the Air Transportation System

When the FAA's "NextGen" program to modernize the national air transportation system was launched in the early 2000s, UAS integration into the NAS was considered a minor demand falling near the bottom of priority lists. ADS-B maturation, implementation, funding, and adoption was critical to provide the backbone for the modern, GPS-based digital airspace. System Wide Information Management, digital data-link communications between aircraft-to-aircraft, aircraft-to-controllers, and other airspace participants, and improved weather impact analysis were considered the top priorities for increasing capacity while maintaining or improving the air transportation safety performance. Based on analysts' predictions and industry trends today, UAS could outnumber traditional manned aircraft ten to one in the not-so-distant future. This exponential growth will require support for a wide range of unmanned aircraft operating in nearly all types of airspace including urban, rural, high density, low density, and various altitudes. UAS have the potential to epitomize the capabilities and benefits of NextGen, while also demanding the expedited, successful transition to the modern aviation system.

Industry Trends and Outlook

Small UAS

Small UAS are the largest growth sector and the primary focus of the FAA for UAS integration in the near future. "Small UAS" is currently defined as 55 pounds or less in maximum takeoff weight of an aircraft (i.e. airframe + payload + fuel). There is a consideration for a "micro UAS" class of aircraft, but current exemptions and waivers apply to all commercial and civilian UAS of small UAS. Small UAS include traditional Department of Defense systems such as the Aerovironment Raven and Puma (Figure 7)

systems, but also the rapidly emerging public consumer type systems such as the DJI Phantom series and the SenseFly eBee. Most of these systems are hand-launched, launched from a small bungee powered catapult, or are vertical takeoff multi-copter designs. Flight time is anywhere from 15 minutes to 4 hours (for the extended range Puma) for aircraft less than 55 pounds, but the top of the small UAS weight range systems that are gas powered have completed 12+ hours missions. Except for a

Figure 7: Puma UAS Launch

handful of research projects, small UAS are flown exclusively Line-of-Sight in the NAS today.

There were early predictions that the 2015 holiday season would see as many as 1 million small UAS sold at the general consumer level. Most of these aircraft would have been be sold as "hobby" devices intended for recreational purposes. However, the commercial potential for these devices is not a far leap into real estate photography, roof inspections, and surveying. That is why the UAS Registration Task Force was assembled to quickly develop a registration strategy as a step toward the release of the small UAS Rule (Part 107) and why the FAA quickly released the Interim Rule defining registration requirements for the hobbyist community.

The package delivery UAS concept (Figure 8) that organizations such as Amazon and Google are researching and evaluating is based on a network of small UAS that can carry an approximate 5-pound payload. Fleets of aircraft delivering toothpaste, books, medical supplies, and other immediate-need orders is not a fictional marketing concept, but an evolving business plan within multiple companies across the globe. Developing technologies for equipping these small UAS for tracking, path deconfliction, all-weather operations, and high-rate utilization are active development programs in research labs.
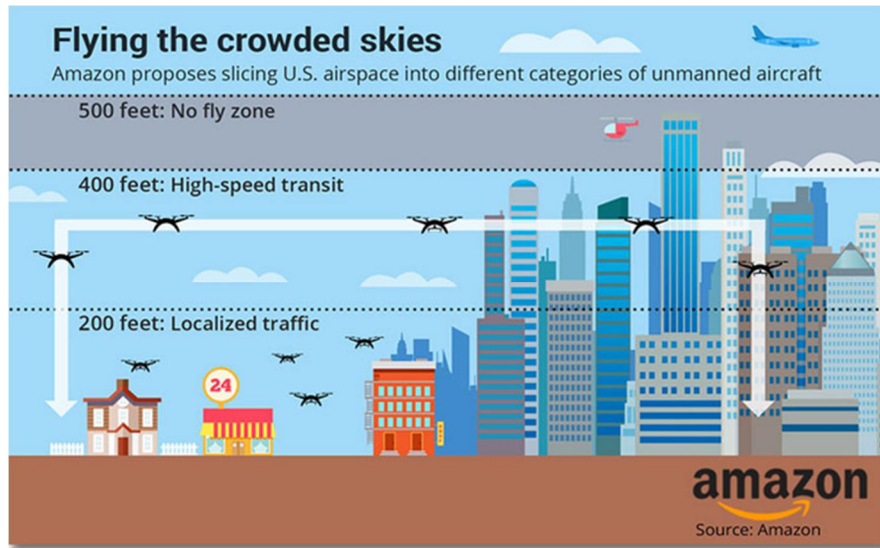
Figure 8: Amazon Airspace Management Concept

Based on the more than 2,200 approved small UAS commercial exemptions in December 2015 and with the release of Part 107 anticipated in the summer of 2016, routine UAS operations in the NAS could be witnessed daily before 2020.

Large UAS

UAS larger than 55 pounds are emerging at a much slower pace than small UAS. Outside of the DOD Predators, Global Hawks, and Shadows, aircraft such as the Yamaha RMAX helicopter (Figure 9) for aerial spraying and the Arcturus T-20, a surveillance aircraft, are rarely seen in the United States NAS. Although large UAS provide more capacity for carrying transponders and other communications capabilities, and they are more likely to show up on radar due to size and higher flight altitudes, their cost and support logistics are significantly more than small UAS. The FAA and standards committees are just beginning to address the demand for Beyond-Line-of-Sight (BLOS) UAS operations.

A growing number of UAS operations, increased use of UAS in complex airspace, and the potential emergence of single-operator-multiple-vehicle control architectures will drive the development of new ATC integration technologies and protocols.

Figure 9: RMAX Aerial Application UAS Preflight

Command and Control

ATC Integration

Air traffic control (ATC) integration for UAS is a multi-faceted challenge. Very small aircraft, flying below 500 feet altitude (very often less than 100 feet), that are only in the air for less than half an hour are not considered a major concern for most air traffic towers. However, for a crop duster operating at less than 500 feet that is actively scanning for new meteorological towers (met-towers) and power lines while making sure to only working specific fields, a small UAS with a camera that is capturing spectral imagery of a neighboring field is considered a serious air traffic threat. Meanwhile UAS operating along the northern and southern borders of the United States in support of Homeland Security Customs and Border Protection programs operate in Class A airspace following instrument flight rules (IFR) with complete communication capabilities for traffic alerting and transponders. To support ATC integration all, FAA approved UAS operations under the Certificate of Authorization program require the posting of a Notice to Airmen (NOTAM) two days before flying. The NOTAM does not restrict the airspace from other users; it is an awareness tool for pilots to be alert for UAS operations in a specified area.

Many companies and researchers are evaluating the UAS-to-ATC communication path as an opportunity for improvement and technology development. A growing number of UAS operations, increased use of UAS in complex airspace, and the potential emergence of single-operator-multiple-vehicle control architectures will drive the development of new ATC integration technologies and protocols. Deconfliction of airspace requires ATC awareness of aircraft operations, aircraft knowledge of position (via pilot or electronic device), and communication between the two for maintaining separation. Unmanned aircraft do not have the same level of autonomy as manned aircraft do today, but as command and control technologies improve and system-wide information management enables airspace participants to make more independent decisions that are shared throughout the system, UAS will integrate with ATC just as any other aircraft does.

Sense-and-avoid technologies, geo-fencing, highways-in-the-sky are technologies that are under development to support not only broader UAS integration, but increased capacity and safety for all modern aviation transportation system users. ADS-B, cellular based aircraft tracking, and the "internet of things in the sky" are concepts that may enable the concept of "free-flight" to fly direct from point-to-point, but they also enable the ability to structure airborne corridors allowing aircraft to self-sequence and self-separate with traditional ATC providing an overall system management function. As unmanned aircraft systems continue to mature, they will take advantage of these technologies to operate under the same rules of the sky and communication protocols that manned aircraft are required to follow.

Data links

Data links are the Achilles heel for UAS integration. Strong, powerful, secure data links enable UAS to perform more complicated tasks by sharing more information with the ground control station (GCS) and ATC regarding aircraft situational awareness. Higher performance data links also means that mission data captured on the aircraft can be shared safely and quickly during flight. Intermittent or unreliable data links require UAS communications architectures to focus on command and control to maintain safety of flight operations and protection of the airspace, which often means storing mission data

onboard the aircraft and downloading after landing. Satellite based communications are expensive for small UAS. Cellular-network based UAS data links are being tested for both navigation data distribution and mission (imagery) data transport. Cellular networks have never been part of the FAA's certification programs, so there is concern about evaluating these resources to meet FAA standards and requirements.

Applications of UAS

Washington State UAS user profiles

There are two types of UAS users in Washington to address: public (i.e. government) agencies, and commercial operators. The authority by which each type of user is allowed to operate and the regulatory requirements on each type are different. Expectations on public agencies for communication transparency, economic efficiency, and data management influence decision making regarding establishment of a UAS program. Commercial users must meet FAA, state, and local regulations for operating UAS and using UAS-acquired data, while demonstrating a cost benefit for using the technology. Applications, user profiles, and a minimum scope of operations for near-term UAS operations in the state are provided below.

- Public Agency Uses:

    – Public safety/Law Enforcement—perform accident investigations, search missions, disaster response and support.
    – Surveying/mapping—flood plain mapping, imaging earthworks projects, DOT construction site management and safety
    – Infrastructure inspections—structural analysis of a buildings and bridges
    – Agriculture—crops monitoring, forestry management, aquatic grass and wildlife (fisheries) monitoring, herd and wildlife management, environment conservation
    – Utilities—power line inspections, treatment facility management
    – Research—public universities, K-12 schools

- Public Agency Profiles:

    – Public agencies will probably use one of two basic models to fulfill UAS operational needs (1) establishment of internal frequent use teams for high tempo operations; or (2) development of an internal capability with approved staff and access to aircraft, but necessarily a dedicated resource. These are explained further in Figure 10.

Frequent Use Teams

A UAS unit that would be active weekly

2 or 3 dedicated flights crews. Each crew has one pilot, two observers, and a data analyst.

Team owns equipment- aircraft, sensors, radios, mobile communications unit, transportation vehicle

On-demand Operations

Need for UAS capabilities just a couple times a year max.

Either maintains 1 flight crew that has other job responsibilities or maintains service agreements with commercial UAS service providers.

Internal team maintains a small UAS capability, leases equipment when needed, or contracts the services as needed.

Figure 10: Types of Public UAS Organization Structures

- Scope of Public Operations
  - o Aircraft are operated under the FAA Public Agency Certificate of Authorization (COA) Process
  - o Aircraft are operated as "public aircraft".
  - o Crews are self-certified to meet a minimum credential, not necessarily an FAA issued private pilot's license.
  - o Aircraft are self-certified as "airworthy".
  - o Altitude limitations are based on the specific COA approval from the FAA.

- Commercial Operator Uses:
  - – Surveyors
  - – Engineering Firms
  - – Film companies
  - – Real Estate companies
  - – Aerial photographers

This list will continue to grow as the technologies mature and the regulations are defined.

- Commercial UAS Operator Profiles:
  - Commercial UAS can most likely be categorized into one of the three types since in Figure 11.
  - Scope of Commercial Operations (as of August 2016)
    - Commercial operations are approved under 14 CFR Part 107
    - Operator must have a Remote Pilot Certificate
    - Aircraft is exempt from an airworthiness certificate, but must be inspected before every flight.
    - Line of Sight operations only.
    - Daylight operations only.
    - Blanket operations are approved 400′ AGL or within 400′ of a structure.

Small UAS Services Business (part-time)	Internal Business Team	Dedicated UAS Services Company
• 1 or 2 experienced, approved UAS operator(s) • Own a small number of aircraft with minimal or specialized capabilities • Contract services for hourly or daily imagery • May be a side job for the operator(s)	• Company has established a UAS unit inside an existing organization • A dedicated flight team(s) is established with pilot, observer, and data manager roles • Own a range of aircraft to meet corporate mission needs	• Company is constructed to offer contract UAS services to a range of clients • Operators are full time staff or contracted • Aircraft are owned • Services rates are formally published

Figure 11: Types of Commercial UAS Organization Structures

UAS Mission Descriptions for Washington State

Other than a limited number of research, homeland security, and commercial operations that are specifically approved by the FAA for Beyond Line of Sight, night operations, or altitudes higher than 500′ AGL, the large majority of domestic UAS operations will be small UAS (less than 55 lbs) operating under the bounds of the Small UAS Part 107 Rule for the near future. In Washington these flights will meet the objectives of public and commercial operators performing the applications described previously. Surveying, agriculture, environmental monitoring, infrastructure inspections, aerial photography,

aeronautical research, and emergency response missions should include the elements described in Table 2:

Table 2: UAS Mission Planning Elements

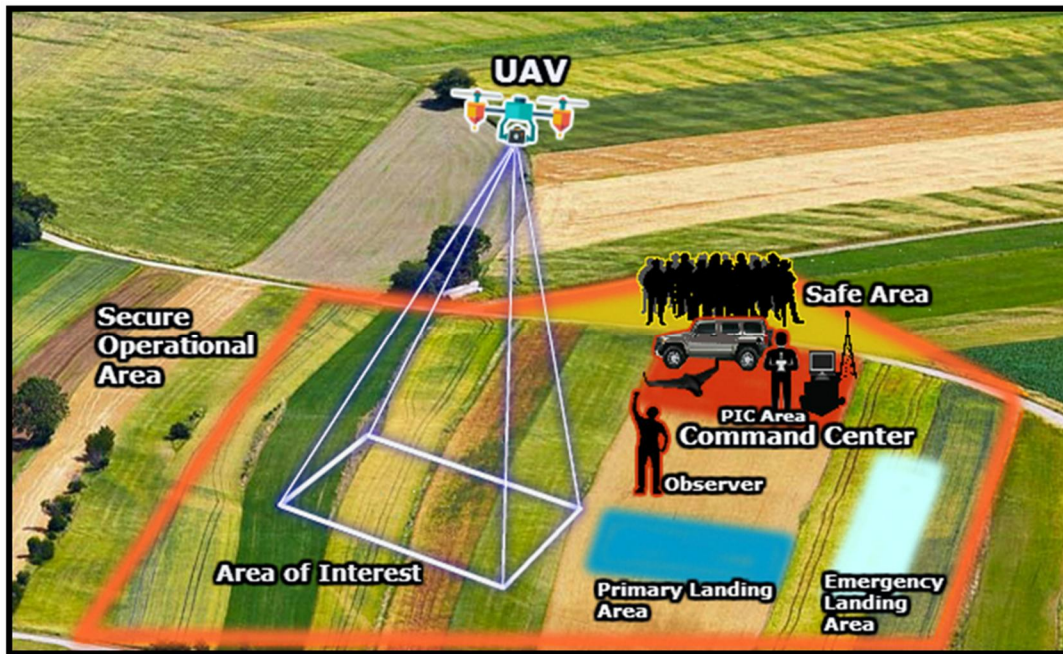| UAS Mission Planning Process		
1	Identify Mission Type	Define the mission application (crop survey, surveying, mapping, building inspection, etc.) and selecting the UAS type to be used to execute the mission.
2	Define Desired Outcomes	Determine the deliverables (for example images or video) for the flight mission.
3	Define Operational Environment	Define the flight area perimeter, the Command Center with the Pilot in Command and observer(s), flight altitude, and any alert areas/structures within the flight box.
4	Review Capabilities and Resources	Review of operator credentials, aircraft inspection, FAA approval to operate, and any additional approvals necessary to operate (land owner permission, nearby airport acknowledgement).
5	Compose Flight Plan (Figure 12)	Describes how the UAS flies during the mission to accomplish the objectives. Includes (1) any limiting factors such as flight restricted area or obstacles; (2) contingency planning with safe routes in the event of a system failure, degraded performance, or lost communication link. Most UAS products offer ground control stations that can be used to develop flight plans, configure the UAS, plus monitor the UAS in flight using a telemetry link. Each flight plan is composed of a sequence of stages, such as take-off, departure procedure, mission area of interest procedures, and return-to-base, which must be followed and adhered to in the correct order.
6	Develop Security Plan	Announcement flight safety briefing, risk assessment, site manager authority.
7	Execute Data Management Plan	Formalized data capture, transfer, distribution management plan.
8	Publish Flight Schedule	Flight crew and equipment, daily and monthly schedules.

Figure 12: Notional UAS Mission Plan Description

An Aviation Rule Making committee is established and preparing recommendations for a broad UAS rule allowing for a wider range of operations and even more applications. The FAA will use lessons learned from the UAS Test Sites, results from the UAS Center of Excellence research, and the traditional regulatory development structures to prepare for the next phase of UAS integration with larger aircraft, operating Beyond Line of Sight, in a wider number of conditions.

Legislation/Policy

Review of Other States' Activities

The National Conference of State Legislatures maintains a comprehensive list of state UAS-related legislation. (NCSL, n.d.) As of the writing of this report (Jan 2016), 20 states have passed legislation related to UAS operations. Most of this legislation is related to protecting citizens' privacy through data management, establishing a UAS Task Force or Commission to develop a state strategy, or to prohibiting operations at state facilities such as around the state Capitol, correctional institutions, or recreational parks. Some specific examples are from the following states:

- Alabama—The Governor established an Alabama Drone Task Force that recommended the Alabama Department of Transportation be designated as the lead state agency on drones and that the task force stays intact to continue monitoring the issue. Their recommendation report was published in January 2015.

- Georgia—In December 2015 the Georgia House of Representatives UAS Study Committee published a report with 15 recommendations for addressing UAS economic development potential, safety, and other operational issues. Recommendations include forming a commission to develop policy and encourage UAS expansion in the state, prohibiting the installation of weapons on drones, keeping

drones from flying in or around certain public properties, making it unlawful for drones to interfere with public safety personnel, prohibiting the use of drones in hunting or fishing, and prohibiting drone operations within some yet-unspecified distance from a public road. The committee also recommended local governments be allowed to restrict drone use on their publicly owned land, and also calling for measures to ensure drones don't invade people's privacy, including requiring law enforcement agencies to get a search warrant before using a drone to collect evidence "in areas where someone has a reasonable expectation of privacy."

- Illinois—In November 2015 the Illinois General Assembly approved legislation establishing the Unmanned Aerial System Oversight Task Force. The task force is chartered to deliver a recommendations report to the governor and the state legislature by July 1, 2016.

- Michigan—Not a regulatory action, but the Michigan Economic Development Corporation provided a $250,000 grant to the Michigan Unmanned Aerial Systems Consortium to promote the growth of the UAS in the state in November of 2015.

- Minnesota—State law became effective in 2015 in Minnesota requiring all UAS to be registered with the Minnesota Department of Transportation Office of Aeronautics. This registration does not apply to recreational aircraft. The fee for registration is $100 for commercial operators.

- Rhode Island—In October 2015 The Special Legislative Commission to Study and Review Regulation of Drones and Unmanned Aerial Vehicles was established to recommend laws, rules, or regulations for operating UAS in the state to the state's House of Representatives.

Cities are also developing UAS specific legislation to manage safety and impacts of the expanding operations. Miami, Chicago, and Deer Trail, Colorado have explored local level legislation to regulate operations of unmanned aircraft within city limits. Some cities have passed legislation, some are considering following the national and state level leadership for guidance, and some are choosing education campaigns or temporary methods to manage potential unwanted UAS activities. Tourist destinations are limiting operations by requiring city council/management approval before any operations are allowed by a specific operator. Other cities are banning operations in parks and other public areas. Some municipalities are temporarily restricting operations during large events, such as Pinehurst, North Carolina reminding the general public that no UAS, drone, remote-control aircraft operations were allowed within the village limits during the PGA major golf tournaments in 2015.

Although the FAA acknowledges in the State and Local Regulation Fact Sheet (FAA, 2015, p. 3) that state and local authorities may pass laws "traditionally related to state and local police power, including land use, zoning, privacy, trespass, and law enforcement operations," there are other areas that states should not encroach on federal authority. The FAA recommends state and local regulators to consult with the FAA when considering "operational UAS restrictions on flight altitudes, flight paths; operational bans, and regulation of the navigable airspace." They also suggest that "mandating equipment or training for UAS related to aviation safety such as geo-fencing would likely be preempted."

Projected Policy Needs for Washington State

At this point, following the FAA's lead with the release of Part 107 will give the state time to watch how other states are performing under approved legislation, how industry is reacting to FAA and other states, and evaluate what is needed based on current activities by Section 333 Exemption approved operators in the state. As of the production of this report, there are approximately 50 Section 333 Exemption holders in the state of Washington (SUASnews, n.d.). The following policy/legislative recommendations are suggested to position Washington with a comprehensive, managed UAS integration strategy.

- A process for monitoring FAA approved operations in the state (333 holders and Part 107 certified pilots). This may be a registration program, a permitting program, or a simple notification mechanism, but it will provide data informing authorities of UAS activity in the state.

- Provide tools for supporting airspace integration such as local airport communications and agreements, positions of routine launch and recovery locations, preferred testing/training locations for new operators. These tools will support the safe integration of UAS by informing the local air and ground community.

- Establish a UAS Integration Commission. This commission should consist of members from Washington DOT, Department of Commerce, Department of Ecology, Department of Agriculture, State Patrol, Technology Solutions, and local universities. This commission should build on the research done by the UAS Working Group established in 2015. The commission should monitor national activities (regulations and policies, research, and commercial developments), internal state activities (industry growth, policy needs), related data privacy developments, security needs (state infrastructure and installations), and airspace safety performance.

- Develop a UAS Education Strategy. Public schools across the state, including community colleges, universities, and even K-12 institutions need guidance for developing UAS education and training programs. Green River College is currently developing a UAS operator training program (Thompson, 2015). University of Washington (Banse, 2015) (Aitchison, 2014) and Gonzaga University (Lindsay, 2015) are example schools developing UAS degrees and on-campus flight policies to manage how UAS are used in research and recreational activities.

- Develop an Economic Development Strategy. The Association for Unmanned Vehicle Systems International (AUVSI) published a report in 2013 predicting the rapid growth of the UAS industry once commercial UAS operations were legal in the United States. This growth correlated to economic growth in jobs and spending related to the proliferation of UAS companies, services, and applications nationwide. The predictions for Washington State are included in Figure 13. The state already has a Legislative Committee on Economic Development and International Relations that is studying the potential growth of the commercial space industry in the state to support local companies like Blue Origin, Spaceflight, Planetary Resources, and others. UAS companies, manufacturers, suppliers, and services providers, are looking for locations that are embracing the technology and encouraging the growth in their regions.
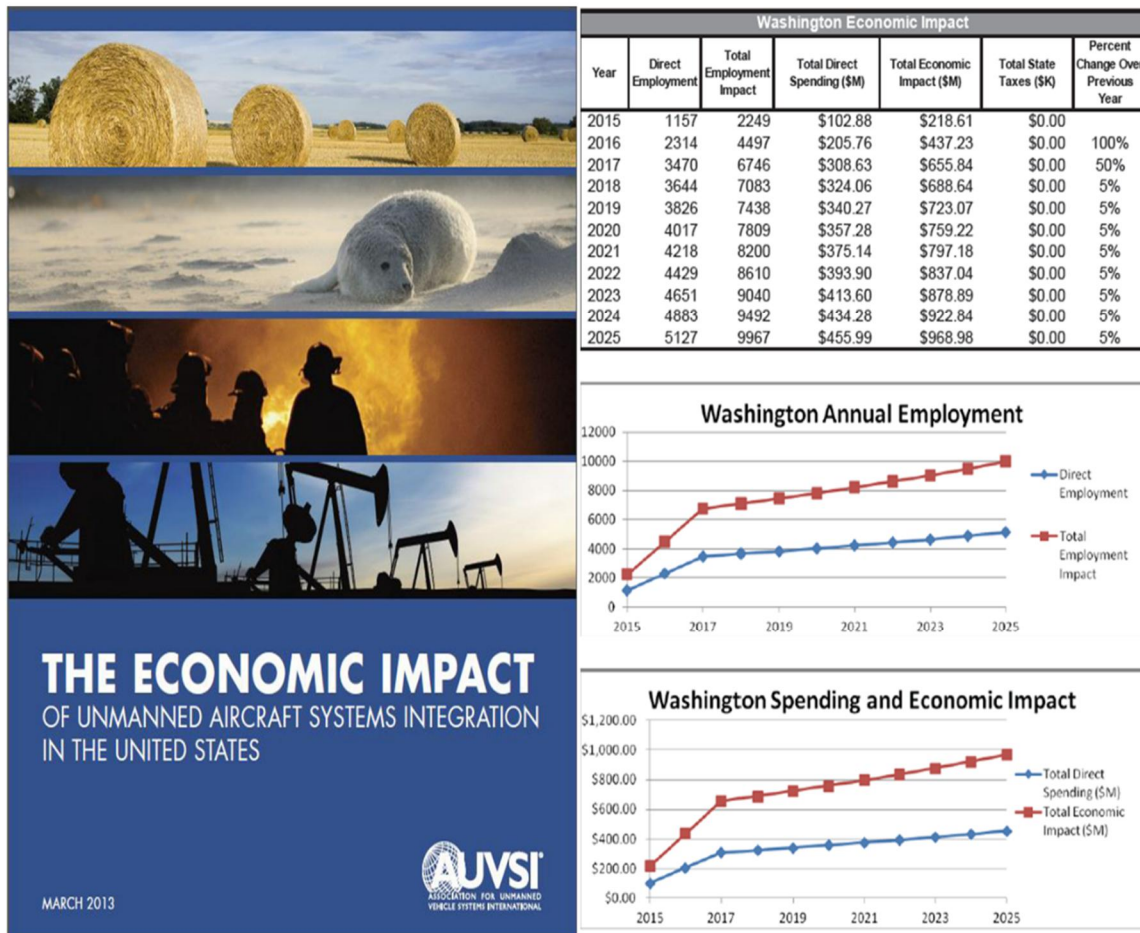
Washington Economic Impact						
Year	Direct Employment	Total Employment Impact	Total Direct Spending ($M)	Total Economic Impact ($M)	Total State Taxes ($K)	Percent Change Over Previous Year
2015	1157	2249	$102.88	$218.61	$0.00	
2016	2314	4497	$205.76	$437.23	$0.00	100%
2017	3470	6746	$308.63	$655.84	$0.00	50%
2018	3644	7083	$324.06	$688.64	$0.00	5%
2019	3826	7438	$340.27	$723.07	$0.00	5%
2020	4017	7809	$357.28	$759.22	$0.00	5%
2021	4218	8200	$375.14	$797.18	$0.00	5%
2022	4429	8610	$393.90	$837.04	$0.00	5%
2023	4651	9040	$413.60	$878.89	$0.00	5%
2024	4883	9492	$434.28	$922.84	$0.00	5%
2025	5127	9967	$455.99	$968.98	$0.00	5%

Figure 13: AUVSI UAS Economic Impact in Washington Analysis

Public Perception and Engagement Strategies

Public perception and engagement is absolutely critical to successfully establishing a UAS program in a government organization. Public agency UAS programs must be built on principles of transparency, regular communications, and commitments to protecting personally identifiable information (PII).

The Seattle Police Department UAS Program failure to launch in 2012 means that Washington has a steep climb to gaining public trust and confidence. (Times, Police apologize for not keeping council in loop on new drones, n.d.) (Times, Seattle grounds police drone program, n.d.) Public understanding of UAS capabilities, policies, applications, and intentions continue to evolve. Governments and advocacy groups are publishing guidelines and standard procedures that have been publicly reviewed and adopted by other organizations. Thorough planning and preparation are essential for any organization beginning UAS operations.

Six suggested Communications Best Practices to support UAS integration are included below.

- Public outreach—Airports looking to introduce UAS into their operations will be well served by actively reaching out to their local communities. The purpose of the outreach should be to educate the public on the aircraft to be flown, the types of activities the UAS will perform, and the risk mitigations implemented to ensure public safety. (Neubauer, 2015, p. 21)

- Building and maintaining community support for UAS operations is a continuous process that goes beyond simply giving the public notice of upcoming operations. The community needs to be informed about the organizations that will be conducting the operations, how the flight activities could impact them, and then given the opportunity to ask questions and express any concerns. A list of topics the airport and UAS operator might present to the public is as follows:

    - Define a UAS

        o Explain the history of UAS operations
        o Describe the different types of UAS

    - Who is doing the flying

        o Overview and history of the organization
        o Safety record and risk management processes
        o Examples of past missions and their results

    - The aircraft and the missions

        o Types of UAS
        o Sensors on board UAS
        o Purpose of the flights
        o Flight routes and restrictions

    - Benefits to the community

        o Economic benefits
        o Safety benefits
        o Environmental benefits

    - Status of regulations

        o Current regulations
        o Proposed regulations

    - The Future of UAS

        o Companies involved in the UAS industry, especially local
        o Future applications of UAS

The topics are best presented by a chosen UAS operator or by persons experienced in the type of UAS operations to be conducted in order to provide the public with the most accurate information and to completely answer any questions the audience might pose. (Neubauer, 2015, pp. 22-23)

- Develop a Communications Plan for those that handle related external communications inside the agency. This plan should be finalized and ready for distribution well before the agency is prepared to take on its first operational mission. The agency should keep the public informed about the changes that would significantly affect privacy, civil rights, or civil liberties. Information will be provided via the public request process.

- Provide an Annual UAS Program Summary Report to the public that summarizes UAS operations during the fiscal year, to include a brief description of types or categories of missions flown, the safety standards maintained and the value provided by using UAS.

- Identify a Public Liaison Officer (PLO) who should be available via email or phone to answer any concerns or questions the people have regarding UAVs.

- Create an Oversite Committee for safety and protection of people and property, both on ground and in the air. The Oversite Committee, which includes at a minimum the Agency PLO, state DOT representative, UAS Industry representative, Law Enforcement and local government representation, should ensure that the agency is maintaining high safety standards. The committee should meet quarterly and should be briefed by the PLO on the progress. The agency should let the committee know if any changes or additions will be made to the proposed program and get the necessary approvals. The committee should review the annual summary report to assess the efficiency and success of the program.

Future Implications

Unmanned Air Cargo

There are many organizations considering unmanned aircraft for cargo delivery. The military has tested and proven the value of using a full-sized helicopter, the K-MAX (Figure 14), for autonomous cargo delivery. There is potential transition of this technology in fire-fighting and other large scale operations. But current corporate analysts are evaluating the business case for routine small UAS package delivery systems, while some companies are already developing and testing potential solutions. Companies like Amazon and Google are working closely with NASA and the FAA to develop not only the aircraft to provide package delivery, but also the rest of the aviation infrastructure necessary to support routine small UAS operations in urban, congested, low altitude airspace.

Three primary principles will shape UAS Cargo adoption in the NAS:

- Autonomous operations are fundamental for routine BLOS operations. Multiple aircraft being managed from a single, remote control station is fundamental to the concept of a distributed network of UAS picking up and delivering packages, providing public safety agencies with real-time video during emergency response calls, or supplying on demand aerial traffic and news monitoring feeds.

- Definition of a warehouse will determine cost benefit. For autonomous package delivery to become cost effective, the definition of warehouse or cargo source may be variable. Whether it is a traditional post office, a large discount market store, a distribution only warehouse, or it is a tractor trailer stocked with temporarily high-demand consumer products-determining the location for basing these operations, coordinating them as UAS launch and recovery sites (aka "droneports") with federal and local authorities, and developing airspace integration plans (approach and departure routes) for each one will be challenging.

- Ownership of cargo UAS may follow the cellphone adoption curve as individual-ability to retrieve and transport cargo becomes feasible. Whether that is launching a personal aircraft to pick up medicine at a pharmacy or sending it home from the field to retrieve forgotten sports gear, when the infrastructure is in place and the technology is mature enough, the benefits of ownership will create the market.

Figure 14: KMAX Cargo UAS in Action

Unmanned Commercial Air Service

The general consensus within the UAS community is that commercial passenger transportation will not transition to a pilotless cockpit any time soon. The pilot may become the co-pilot to the autopilot, fulfilling the role of system manager, but a human will remain in the cockpit for a multiple reasons.

Commercial cargo services, however, have received significant research and business case analysis for assessing the potential value of unmanned operations. Especially long-haul flights across the Atlantic and Pacific Oceans, autonomous commercial cargo operations are considered economically practical.

Both of these concepts are natural extensions of current capabilities in commercial airlines and large DOD unmanned aircraft programs. Autonomous takeoff, navigation, and landing has been performed thousands of times with large aircraft. Integration into commercial airport terminal operations and contingency management are the primary areas for research into technology and procedure development.

Unmanned Local Passenger Transport (Aerial commuting)

As autopilots and vehicle management systems continue to advance and the NextGen system matures, the line between manned and unmanned aircraft will begin to blur. Personal Aircraft Systems that are highly efficient, semi-autonomous air taxi services will operate as large UAS carrying commuters as cargo with pilots that are more "system managers" than aviators. An FAA Aviation Rulemaking Committee committed to developing recommendations for large UAS integration is established and preparing a report for the FAA. The expected release date for that report is not yet determined. In January 2016 the Chinese Company eHang announced the development of an autonomous personal

transport vehicle the eHang184 (Figure 15). In August of 2016 the Airbus innovation group in Silicon Valley announced Project Vahana as an autonomous airborne personal transportation system research project evaluating aircraft and airspace structure concepts (SUASnews, n.d.). Much like the introduction of the consumer-targeted small multi-copter in 2013, the physical production of functional aircraft has a way of impacting reality.

Anticipated Impacts on Washington Air Transportation System

Impacts on Airports

As reflected in the ACRP UAS Primer Report (Neubauer, 2015), there are two overarching considerations that stakeholders would be well served by addressing when developing an airport's UAS vision. First,

airports should consider the types of UAS that can be expected and the number of operations anticipated. Most small UAS operations do not require an airport and are expected to stay at least 5 miles away from airports. So if an airport is intentionally attracting UAS business and activity, a detailed description may need to be in the airport strategic plan. Second, airports should determine the facilities necessary and currently available for UAS activities, including a communications

Figure 15: eHang184 Concept Vehicle

infrastructure. A vision for UAS operations could be integrated into the master plan, or an airport strategic plan or financial plan if those are more applicable vehicles, and take into consideration tasks needed for UAS development and provide a roadmap for this change in airport operations.

The most likely airport interaction situation is that UAS will co-exist with manned aircraft on the airport, on runways and taxiways, and in the airspace to the extent the FAA determines an acceptable level of safety is provided. Operations near the airport (within 5 miles) will require ATC approval.

Operations

Airports may benefit by making sure the rates for services and facilities paid by UAS operators are comparable to those paid by the manned aircraft community in order to avoid conflicts and ensure operational cooperation.

It is commonly accepted that large UAS operations require more support than manned aircraft from the ground, and perhaps in the air, because of the necessary communications and control protocols. This trend is worth tracking to assess planning and impact strategies.

Understanding and communicating any restrictions placed on manned aircraft operations to the tenants based at the airport, and to known transient users, will be important for airport operators. This will allow airport tenants and known transient aircraft pilots to adjust schedules and flight plans accordingly.

Infrastructure

As the airport makes preparations for recruiting UAS, taking inventory of available facilities that potentially meet UAS operator needs is an important early step. The goal of the inventory is to help ensure an airport does not turn UAS operations into a negative revenue situation.

The considerations for infrastructure requirements should start with some basic questions from the airport to the UAS operator: (Neubauer, 2015, pp. 20-21)

- Does the UAS need a runway for takeoff, landing, or both? If so, what runway length and width is required?

- Can the UAS taxi to/from the runway and follow ATC commands and other voice commands?

- Does the UAS company need hangar space when not flying?

- Does the UAS company need ramp space prior to or after flight?

- What sort of control station is required (truck, trailer, office space, etc.)?

- Does the UAS need launch and recovery space (in lieu of a runway)? If so, how close to the airport does this space need to be?

- What sort of communications infrastructure is needed? Does the UAS operator need special towers of antennas in order to ensure communications are established and maintained with the UAS?

- Will the communication frequencies needed create conflicts? Will they interfere with existing frequencies used by airport staff, the FAA, tenants, airlines, fixed base operators, or others?

- Will the UAS need special emergency standby equipment? Is it available at the airport or does it need to be brought in from an outside source? As an example, a large general aviation airport might need to bring in a local fire department truck to standby for UAS operations as a matter of protocol.

"Long-range planning for land use and UAS is a slightly different matter. Airport operators are encouraged to take a master planning approach in creating a vision for future UAS operations. Land-use planning is an important aspect of this approach. Long-range planning about where permanent ground based control stations might be located, as well as where to place storage and maintenance facilities that may require airfield access might be prudent approaches for those airports looking to attract UAS operators.

For those airports that receive FAA grant funds, it will be important for the airport management to ensure there are no land-use issues that violate the grant assurances. Airport operators are encouraged to have a discussion with their FAA Airport District Office (ADO) prior to executing agreements with UAS operators for airport facilities or property. The property itself might be encumbered in such a way that UAS use might not be permitted. This is highly unlikely, however, given that the FAA and the NTSB have determined that UAS are aircraft. Moreover, local zoning laws and local restrictions might prohibit such activity. It will be up to the airport management to investigate and ensure UAS operations do not violate any restrictions. Land-use issues are listed on the UAS checklist in Appendix C for reference." (Neubauer, 2015, pp. 32-33)

Impacts on Washington Airspace

Any increase in UAS operations directly increases the utilization of Washington airspace. Class G airspace in suburban and rural areas with low population densities will have most of the early UAS-proliferation integration. Flight operations over large groups of non-participating people are banned for public COA operations, commercial 333 exemption operations, and Part 107 operations. The FAA is expected to a release an NPRM for small UAS flights over people, aka "the Micro UAS Rule," in December of 2016. Line-of-sight restrictions will keep small UAS flying under VFR conditions, even though they will be operating as IFR flight plans. Commercial and business aviation should anticipate minimal UAS interaction from approved-UAS operations while the small UAS Rule (Part 107) is the primary managing regulation keeping aircraft small, operating at low altitudes, and relatively small areas. Once a method for BLOS, highly autonomous operations is established, then altitudes higher than 500' AGL and more urban operations can be expected because technology for sense-and-avoid, obstacle detection, traffic alerting, and dynamic flight planning will have matured and been certified by the FAA. When that happens we can expect to see established UAS terminal facilities, flight routes and fixes published on aviation charts.

While the transition to a UAS integrated airspace, NextGen technology roll-out (ERAM, SWIM, ADS-B, etc.), and related regulations are evolving, airspace users need to maintain superior vigilance and communications within the community. Rogue UAS operations are to be reported to local law enforcement and/or directly to the FAA. Responsible UAS operators should be posting NOTAMs to make the airspace community aware of planned activity. Information sessions to either share goals for planned UAS operations or reach out to burgeoning UAS services groups will help protect the integrity of the airspace. As the FAA approaches 3,000 approved Section 333 Exemptions to provide civilian UAS services, the future of the air transportation system where UAS outnumber manned aircraft at least two to one is not unrealistic. The FAA's NextGen program was launched to increase the capacity of the NAS. UAS already require that increased capacity, even if it utilization of low altitude airspace that has historically had low use.

Impacts off Airports

The broad approval of small UAS operations means aviation becomes more local. Whether it is a once-per-project operation to scan a new construction site before breaking ground, or the establishment of UAS-package delivery service corridor that runs around the perimeter of a small suburban community, UAS are breaking the traditional tie between aircraft and airports for performing airborne operations. Airspace is a global resource that exists everywhere. UAS can provide value to a homeowner flying three feet over his roof to do an inspection or 50 feet over his property to survey his yard in planning a garden or grass treatment program in the spring. Another service provider may offer an in-town courier service to retrieve and deliver high priority packages, while using a subscription-based protocol for launching and landing at previously surveyed drone pads that are on building tops, driveways, or other defined areas. UAS are offering new ways to use the natural resource of accessible airspace in a much more dynamic, multi-purpose, adaptive capacity that has ever been available since the dawn of powered flight in 1903.

Access to the airspace is a regulated privilege that is becoming accessible by the general population, but it is still restricted to those that follow the rules. Just as cars that are unregistered (no license plate) and drivers that are uninsured and unlicensed are not legally allowed to operate within the national ground transportation roadway and highway system, the same principles apply to the aviation system. Infrastructure is under development that will enable UAS (and all aircraft for that matter) connectivity and tracking at all times. Aircraft launch and recovery launches will grow as UAS and new manned aircraft, such as the Terrafugia Transition, used fixed and temporary locations, which may be airports, streets, rooftops, or even a front yard, for terminal procedures. As demand for UAS to carry bigger payloads (cargo or imaging systems), the aircraft size will increase, which will correlate to an increased use of existing airports or increased development of new launch and recovery pads. In addition to the expanded physical infrastructure, the digital infrastructure to support GPS-defined 4-dimensional aerial pathways, aircraft-to-aircraft, aircraft-to-ATC, aircraft-to-ground communications will mature creating a digitized sky. The ability to track all aircraft in the air or on the ground while providing new services via access to the airspace using UAS will make aviation a routine, local experience that does not require a visit to a local airport.

Public Policy

Washington State Government UAS Management

Licensing, permitting, and registration programs

Many states are evaluating or activating UAS permitting or registration programs to provide a holistic management structure within the state regulatory authority. Some of these actions are intended to demonstrate foresight and leadership at the local level while the FAA wrestles with a national strategy and regulatory structure. Although the state registration programs cannot supersede or replace FAA requirements, they provide possible revenue and information sources at the local level. Two examples of states with registration and permitting programs are Minnesota and North Carolina.

- Minnesota's approach: Under Minnesota state law, Unmanned Aerial Systems (UAS) or drones, are required to be registered with MnDOT Office of Aeronautics. State Registration is not required for unmanned aircraft operated solely for recreational use. Commercial operators are required to obtain a licensed from MnDOT before they advertise, represent, or hold themselves out as giving or offering to provide UAS services. (MNDOT, n.d.)

- North Carolina's approach: The North Carolina General Assembly passed legislation in 2014 requiring UAS operators to pass a Knowledge Test in order to obtain a UAS permit to operate within the state. This Knowledge Test is designed to ensure safety of operations and safety of those in the operating area, in addition to providing evidence of understanding related laws such data privacy and the requirement for permission to take-off and recover UAS on public and private property. (NC GS § 63-95) The UAS Permit is required for commercial and public operators and is issued by the North Carolina Department of Transportation Division of Aviation. (NC GS § 63-96)In December 2015 the FAA began the mandatory UAS registration program for all aircraft weighing less than 55 pounds and more than 0.55 pounds (250 grams) on takeoff. Failure to register may result in a direct fine

from the FAA. Although initial registration process was just for hobbyists, the registration requirement applied to all aircraft as commercial and publicly operated UAS were required to follow the traditional N-number registration process until the streamlined process for small UAS was released in May of 2016. Any state level registration regulations are in-addition to these federally posted requirements. (NCDOT, n.d.)

Enforcement

In December of 2015 the FAA issued a press release titled "Law Enforcement Guidance for Suspected Unauthorized UAS Operations." (FAA, 2015) The FAA uses this guidance document to recognize that "state and local Law Enforcement Agencies (LEA) are often in the best position to deter, detect, immediately investigate, and pursue enforcement actions to stop unauthorized or unsafe UAS operations." The FAA is actively working with LEAs to provide up-to-date information on regulations, activities, and developments related to UAS integration into the NAS. In addition to framing the FAA's authority to regulate UAS operation, including model aircraft, the guidance document also outlines six functions for local LEAs to assist the agency regarding UAS flights.

- Witness Identification and Interviews

- Identification of Operators

- Viewing and Recording the Location of a Reported Event

- Identifying Sensitive Locations, Events, or Activities

- Notification to the FAA Regional Operation Center

- Evidence Collection

Given the growing interest in UAS and still widely held civic safety and privacy concerns, one opinion is that the public will become the enforcers of the regulations. As more and more UAS fly, and the flying increases in frequency in populated areas, it is possible that people may become concerned with the activity and call police or the local airport to report the UAS operations they see.

Airport managers and operators can be a positive force in ensuring safe UAS operations by staying abreast of the rulemaking process and UAS related stories. The FAA regularly posts news releases relating to the status of UAS regulation on the FAA website, and news on advancing UAS technologies can be found on the Internet. Airport operators should be ready to respond to questions and concerns from the public about unmanned aircraft.

Washington State Public Safety, including state and local officers, may consider developing policies for collaborating with FAA for UAS regulatory enforcement, while also working with the state Department of Justice to determine state-level UAS law enforcement protocols. The FAA's experience with enforcement has included "stop and talk" interviews for awareness, formal warning letters, and fines, preferring not to use methods that require court orders or potential use of force by law enforcement personnel.

Managing public agency operations

Public agencies in Washington may benefit from the access to information about UAS capabilities just as commercial organizations do. Low cost, on demand, frequent capture of aerial imagery is valuable for making many decisions. Public agencies may want to consider development of policies to manage their wide range of operations. A possible list of baseline policies includes the following:

- Data Management, Including Handling Personally Identifiable Information, Policy

- Contract UAS Services vs Building Internal Capabilities Policy

- Platform Selection Policy

- Crew Selection Policy

- Manned or Unmanned Operations Selection Policy

- Access to Land Policy

- Training Policy

- Reporting/auditing

- Procurement Policy

Washington State Policy Considerations

The following considerations are influencing the proliferation of UAS and should be considered by regulatory agencies involved in UAS policy development.

- UAS service companies are not supportive of having to be licensed/permitted everywhere. Lawyers, construction firms, mortgage brokers understand the value of local and federal regulations for protecting their trade and meeting the expectations of the local community.

- Infrastructure to establish a licensing/permitting program could be a significant undertaking. Tying it to the evolving FAA program is complicated as cross referencing to a COA, Remote Pilot Certificate list, or National Drivers' License database could be involved.

- What is the intent of a permitting program? There is debate on the value of state level legislation versus implementation of an extensive education campaign. Responsible companies and government agencies are not the threat to safety and data misuse. The rogue, uninformed, over-confident operators are the threat to the system and there is not clear data that additional regulation reduces those activities.

- Corporate programs versus operator-based programs will rise. Warehouses offering routine package distribution via UAS will increase noise, airspace congestion, and potentially use other modern infrastructure (cellular networks for instance). These kinds of operations, in addition to small, discreet operations that are becoming more frequent today, present opportunities for creative revenue streams for governments committed to protecting citizens and capitalizing on local resources.

- Cargo/package delivery is considered cost beneficial to companies that have large volumes of delivery. These business cases and others that are demonstrating financial and public value, such as increased situational awareness in a 911-response call scenario, are driving the accelerated adoption of UAS in the NAS and the related-technology advancements necessary to increase performance, reliability, and capabilities.

- Driverless cars with autopilots, small aircraft with advanced autopilots and avionics, increased access to global communication structures and bandwidth- these trends are opening new transportation capabilities around the planet. UAS will benefit and contribute to this new age of connected, intelligent transportation.

Protecting the Public through Aviation Safety

Aviation safety is the primary responsibility of the FAA. That responsibility includes the management and deconfliction of the airspace, as well as the protection of the safety of the ground and public below the airspace. As the December 2015 guidance document for state law enforcement agencies states, "The FAA has promulgated regulations that apply to the operation of all aircraft, whether manned or unmanned, and irrespective of the altitude at which the aircraft is operating." The emergence of UAS as disruption to traditional aviation is forcing FAA and other legal authorities to review the definitions of aviation concepts such as "aircraft", "navigable airspace," airspace sovereignty, aerial curtilage, airworthiness, and "sense and avoid." The FAA is working with federal, state, and local law enforcement agencies to understand the federal legal position to support nationwide enforcement of UAS and other aviation regulations to protect the safety and integrity of the aviation transportation system.

The FAA has increased the communications and outreach activities of the agency to share the progress in the development of a broad small UAS rule (Part 107) as the agency transitions away from the exemptions and waivers programs of COAs and the Section 333 exemptions. The state should enable these communications between state LEAs and the FAA, but should also provide mechanisms for local aviation stakeholders to interact with the emerging UAS community, local LEAs, and state authorities to develop Washington-specific programs for ensuring airspace safety. Education and communication are just influential in the dynamic UAS landscape as regulations and enforcement are. Building a user community and general public that are informed about the complexity of the air transportation system, the current regulations, and the proper methods for utilizing airspace is as big a challenge as developing new technologies for capitalizing on the resource.

UAS are expected to perform in the NAS at an equivalent level of safety or better than manned aircraft. This means that UAS must sense-and-avoid potential conflicts on the ground during taxi and in the air during flight operations. Published flight plans, or at least defined pathways in the sky, are under consideration and development as a method for managing large numbers of UAS in routine operations. These flight corridors may be predetermined (FAA or local agency defined) or submitted in a traditional "file-and-fly" structure in the future. As the protocols mature, the flight plans will maximize efficiency of flight operations, while considering flight contingencies, ground factors such as obstacles, populations, and radio interference, and regulatory constraints. UAS will not be allowed for routine operations in the

NAS if either the risk to other airspace users or the public on the ground is too high or regularly jeopardized.

To address these concerns, Washington should consider getting involved in standards committees and support research initiatives addressing the challenges. The concerns regarding UAS risks and noise flying over populated areas, the role of local enforcement engaging the public on federal aviation law, the need for UAS operators to report all planned flight activity are all valid; data is needed to determine the proper direction for removing these concerns. There are many active research efforts related to these concerns the FAA through the ASSURE UAS Center of Excellence, the Transportation Research Board (TRB) through Airport Cooperative Research Program (ACRP) projects, DOD through SBIRs and other initiatives. To take a leadership role and shape these decisions, policy and technology assessment and development research is necessary.

Airport staff need training related to UAS integration. "In addition to the physical differences of the aircraft and facilities, airport personnel should also be made aware of any communication requirements for UAS. Airport personnel should understand any potential impacts to locally used radio frequencies, microwave links, or other communication systems. Understanding these impacts will support the safety of the UAS operation, the performance of the air transportation system, and the protection of the ground and public beneath the operations." (Neubauer, 2015, p. 40)

Although some accidents are truly accidents and unavoidable, establishing rules and standards to minimize accidents is a high priority for public and commercial UAS stakeholders. The Pier 57 Great Wheel tourist venue in Seattle was recently visited by a small UAS that lost control and crashed into the empty outdoor patio on November 11, 2015 (Times, Drone hits Seattle's huge Ferris wheel; SPD investigating, n.d.). This is a densely populated area with many flight planning challenges where no hobbyist or commercial UAS operator should have been flying an aircraft. Finding the balance of laws, technologies, and education to reduce the risk of dangerous, undesired, illegal activities is challenge facing the entire UAS community for the present and future.

Summary

Infrastructure Impacts

The initial impact of small UAS for commercial and public operations on the Washington Aviation System is expected to be minimal. Most small UAS operations are restricted to less than 400' AGL for an operating altitude via the FAA regulations. All of these operations are limited to line-of-sight operations only and for aircraft less than 55 lbs. (most less than 15 lbs); that distance is usually less than one mile range. These operations will either use existing resources, including cellular networks, Unicom stations, and the NOTAM system for announcing operations, or they will bring the additional resources necessary for operations and also approved by the FAA.

Beyond small UAS, line-of-sight operations, the Washington transportation infrastructure can expect continued increased demands on communications and connectivity networks, especially with more UAS requiring communications for control and [mission] data transfer. The development of autonomous package delivery UAS systems will be required to integrate into the existing aviation structure, but may

require additional resources for registering aircraft, takeoff and recovery locations, and fixed flight paths. The GPS-based navigation and tracking protocol that is the backbone to the FAA's NextGen program is designed to support the digitally-native UAS communication needs. More connectivity and communications between aircraft (manned or unmanned) supports better decision-making throughout the aviation transportation system, so NextGen advancements are beneficial and critical to modernizing aviation.

General Aviation Airports Impact

Near term growth of small UAS should have minimal impact on the network of airports in Washington. Most commercial small UAS operations use aircraft weighing less than 15 lbs. at takeoff and can only fly within five miles of an airport with prior approval from the local air traffic control facility (or airport manager). As UAS integration increases, coordination with airports will provide the preferred path to the manned aviation community to support communications regarding the increased number of UAS activities in a local area.

GA airports can also explore potential opportunities for growth as larger UAS integrate or UAS companies look to move into aviation industrial parks attached to airports for connecting to the local aviation community. Airport operators who have been or are now actively receiving grant funds, AIP grant funds in particular, should treat a new UAS operator as they would any new operator or tenant. (Neubauer, 2015, p. 30)

Other recommendations for General Aviation Airports to consider in preparation for UAS integration are seen in Table 3 from the ACRP UAS Primer.

Table 3: Airport Recommendations for UAS Integration (Neubauer, 2015)

Airport Action	Benefits to the Airport
Engage with a UAS National Test Site	Test sites have available segregated airspace; COAs in place; potential research requirements for airports.
Engage with Area Universities	Multiple universities offer UAS related courses; multiple universities conduct UAS research; universities are partnered with national UAS test sites and Center of Excellence proposal teams.
Contact State Government	Departments of Aviation; Commerce, Agriculture and Forestry; Mines, Minerals, and Energy; state police may be potential advocates for UAS business at airports.
Attend UAS Conferences and Seminars	Conferences and seminars on aspects of the UAS industry are conducted regularly to network and become informed on upcoming technologies.
Investigate Complementary UAS Businesses	Research UAS businesses that could be supported by the airport or by the local economy.
Determine UAS Facility/Infrastructure Requirements	Inventory airport facilities and infrastructure that could be used by UAS operators for marketing purposes.
Contact the FAA	FAA Office of Airports (ARP) and FAA UAS Integration Office (AFS-80) can inform and offer direction to interested airports.

Legislative Analysis

Based on current FAA policies and a survey of other state legislative activities regarding UAS integration, the following five recommendations are provided for Washington.

- Construct a process for monitoring FAA approved operations in the state (333 holders and Part 107 certified operators).

- Provide tools for supporting airspace integration such as local airport communications and agreements, positions of routine launch and recovery locations, preferred testing/training locations for new operators.

- Establish a UAS Integration Commission.

- Develop a UAS Education Strategy.

- Develop an Economic Development Strategy.

Preparation Strategies

The following recommendations are general guidance supporting the communication strategy of "Educate over legislate" to support the growth of UAS in Washington, while preparing for a sensible regulatory structure.

- Follow FAA leadership and guidance on UAS adoption.

- Encourage routine communication between the emerging UAS operations community and existing aviation system community.

- Legislate specifics to protect WA citizens and critical infrastructure.

- Require state registration of UAS service providers that intend to operate in the state.

- Educate on proper use, approved (federal and state) legislation, local training resources, and available information sources (WSDOT UAS Fact Sheet)

The mischievous, criminal, intentionally uninformed cannot be stopped by more legislation. More public awareness of proper use and enforcement/reporting mechanisms is an effective deterrent.

Future Expectations

UAS are entering more airspace nationwide on a daily basis. The transition to remotely operated aircraft is the natural evolution of aviation technology. From Wright Brothers' performed wing-warping, to manual controls, to hydraulic assist, to fly-by-wire, to fly-by-satellite, unmanned aircraft provide another method for man to experience flight. UAS are not the discovery of something new, but rather the next step in human ingenuity improving a technology to do more. States should strive to embrace the dynamic nature of the industry with minimal laws and restrictions while still protecting citizen rights and safety and encouraging innovation or many of the economic benefits may go somewhere else.

All of aviation is changing over the next 10-15 years as the airspace environment becomes a digitized 3-D world. UAS will be a piece of the Intelligent Transportation System that connects and reports participants, non-participants, infrastructure, and system status.

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Appendix A: Recommendations from WSDOT UAS Working Group

These recommendations came from the UAS Working Group meeting in October 2015.

1. Larger UAS should operate with the same requirements as manned aircraft.

2. As related to off-airport UAS activity (such as amazon prime air or Domino's pizza) government should know where commercial launch and recovery (VTOL) pads are located.

3. Government should establish policy for zones where UAS activity should be prohibited or regulated. Factors such as safety, noise, privacy, and inappropriate use (e.g. commercial activities) should be considered, and areas such as schools, public events, hospitals and assisted living facilities, certain residential zones, etc., should be considered and addressed.

4. Until technology enables co-use of airspace, UAS should be prohibited from operating in Hub airport airspace.

5. Unmanned activity at non-towered airports should require an operator to communicate with manned aircraft on the CTAF/UNICOM.

6. WSDOT should facilitate a process for establishing GeoFencing, and support the development/implementation of a universal standard.

7. WSDOT should assist in the development of documentation to address new infrastructure requirements to support UAS (e.g. power, hazardous materials disposal [batteries], etc.)

8. WSDOT should support and facilitate the development/clarification/promulgation of procedures for close-proximity manned (crop duster) and unmanned aviation agriculture operations.

Appendix B: FAA Overview of Small UAS Rule, Part 107

Table 1: Summary of the Major Provisions of part 107

Operational Limitations	• Unmanned aircraft must weigh less than 55 lbs. (25 kg).
	• Visual line-of-sight (VLOS) only; the unmanned aircraft must remain within VLOS of the remote pilot in command and the person manipulating the flight controls of the small UAS. Alternatively, the unmanned aircraft must remain within VLOS of the visual observer.
	• At all times the small unmanned aircraft must remain close enough to the remote pilot in command and the person manipulating the flight controls of the small UAS for those people to be capable of seeing the aircraft with vision unaided by any device other than corrective lenses.
	• Small unmanned aircraft may not operate over any persons not directly participating in the operation, not under a covered structure, and not inside a covered stationary vehicle.
	• Daylight-only operations, or civil twilight (30 minutes before official sunrise to 30 minutes after official sunset, local time) with appropriate anti-collision lighting.
	• Must yield right of way to other aircraft.
	• May use visual observer (VO) but not required.
	• First-person view camera cannot satisfy "see-and-avoid" requirement but can be used as long as requirement is satisfied in other ways.
	• Maximum groundspeed of 100 mph (87 knots).
	• Maximum altitude of 400 feet above ground level (AGL) or, if higher than 400 feet AGL, remain within 400 feet of a structure.
	• Minimum weather visibility of 3 miles from control station.
	• Operations in Class B, C, D and E airspace are allowed with the required ATC permission.
	• Operations in Class G airspace are allowed without ATC permission.
	• No person may act as a remote pilot in command or VO for more than one unmanned aircraft operation at one time.
	• No operations from a moving aircraft.
	• No operations from a moving vehicle unless the operation is over a sparsely populated area.
	• No careless or reckless operations.
	• No carriage of hazardous materials.
	• Requires preflight inspection by the remote pilot in command.
	• A person may not operate a small unmanned aircraft if he or she knows or has reason to know of any physical or mental condition that would interfere with the safe operation of a small UAS.

	• Foreign-registered small unmanned aircraft are allowed to operate under part 107 if they satisfy the requirements of part 375.
	• External load operations are allowed if the object being carried by the unmanned aircraft is securely attached and does not adversely affect the flight characteristics or controllability of the aircraft.
	• Transportation of property for compensation or hire allowed provided that-
	   o The aircraft, including its attached systems, payload and cargo weigh less than 55 pounds total;
	   o The flight is conducted within visual line of sight and not from a moving vehicle or aircraft; and
	   o The flight occurs wholly within the bounds of a State and does not involve transport between (1) Hawaii and another place in Hawaii through airspace outside Hawaii; (2) the District of Columbia and another place in the District of Columbia; or (3) a territory or possession of the United States and another place in the same territory or possession.
	• Most of the restrictions discussed above are waivable if the applicant demonstrates that his or her operation can safely be conducted under the terms of a certificate of waiver.

Remote Pilot in Command Certification and Responsibilities	• Establishes a remote pilot in command position.
	• A person operating a small UAS must either hold a remote pilot airman certificate with a small UAS rating or be under the direct supervision of a person who does hold a remote pilot certificate (remote pilot in command).
	• To qualify for a remote pilot certificate, a person must:
	   o Demonstrate aeronautical knowledge by either:
	      ☐ Passing an initial aeronautical knowledge test at an FAA-approved knowledge testing center; or
	      ☐ Hold a part 61 pilot certificate other than student pilot, complete a flight review within the previous 24 months, and complete a small UAS online training course provided by the FAA.
	   o Be vetted by the Transportation Security Administration.
	   o Be at least 16 years old.
	• Part 61 pilot certificate holders may obtain a temporary remote pilot certificate immediately upon submission of their application for a permanent certificate. Other applicants will obtain a temporary remote pilot certificate upon successful

	completion of TSA security vetting. The FAA anticipates that it will be able to issue a temporary remote pilot certificate within 10 business days after receiving a completed remote pilot certificate application. • Until international standards are developed, foreign-certificated UAS pilots will be required to obtain an FAA-issued remote pilot certificate with a small UAS rating. A remote pilot in command must: • Make available to the FAA, upon request, the small UAS for inspection or testing, and any associated documents/records required to be kept under the rule. • Report to the FAA within 10 days of any operation that results in at least serious injury, loss of consciousness, or property damage of at least $500. • Conduct a preflight inspection, to include specific aircraft and control station systems checks, to ensure the small UAS is in a condition for safe operation. • Ensure that the small unmanned aircraft complies with the existing registration requirements specified in § 91.203(a)(2). A remote pilot in command may deviate from the requirements of this rule in response to an in-flight emergency.
Aircraft Requirements	• FAA airworthiness certification is not required. However, the remote pilot in command must conduct a preflight check of the small UAS to ensure that it is in a condition for safe operation.
Model Aircraft	• Part 107 does not apply to model aircraft that satisfy all of the criteria specified in section 336 of Public Law 112-95. • The rule codifies the FAA's enforcement authority in part 101 by prohibiting model aircraft operators from endangering the safety of the NAS.